DATA PAPER

Multifaceted Interactions between Urban Humans and Biodiversity-related Concepts: A Developing-country Data Set

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ABSTRACT

Urban humans and biodiversity-related concepts are interacting with each other in many negative and positive ways. The biodiversity provides a wide array of provision and cultural-ecological services to urban residents, but it is being overexploited to the point of crisis. The crisis is largely driven by the expanding illegal wildlife trade in developing countries with a high urbanization rate and biodiversity level like Vietnam. While supply-side measures are ineffective in reducing biodiversity loss, researchers have suggested demand-side measures as supplements, such as social marketing campaigns and law enforcement in urban areas. Moreover, urban residents are also potential visitors to urban public parks and national parks, which helps generate finance for biodiversity preservation and conservation in those places. Understanding how urban residents' perceptions towards biodiversity and biodiversity-related behaviors can help improve the effectiveness of conservation efforts and sustainable urban development. Thus, this article presents a data set of 535 urban residents' wildlife consumption behaviors, multifaceted perceptions and interactions with biodiversity-related concepts, and nature-based recreation demand. The data set is constructed with six major categories: 1) wildlife product consumption, 2) general biodiversity perceptions, 3) biodiversity at home and neighborhood, 4) public park visitation and motivations, 5) national park visitation and motivations, and 6) socio-demographic profiles. These resources are expected to support researchers in enriching the lax literature regarding the role of urban residents in biodiversity conservation and preservation, and help policymakers to find insights for building up an "eco-surplus culture" among urban residents through effective public communication and policymaking.

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1. INTRODUCTION

Biodiversity loss is happening at an unprecedented rate. Since 1970, the population sizes of mammals, fish, birds, amphibians, and reptiles have declined rapidly by 68% on average [1]. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) reports that around 1 million species are threatened with extinction [2]. Among 35 biodiversity hotspots, the Indo-Burma hotspot is in the top five most threatened places, with only 5% of the natural habitat remaining and the highest human population compared to other hotspots [3]. Being located in the Indo-Burma, the disappearing rate of endemic species in Vietnam is also alarming. In particular, Vietnam Red List in 2007 identified 882 threatened and endangered species (418 animals and 464 plants), showing an increase of 22.33% (161 species) compared to the first published Vietnam Red List in 1992 [4].

The interactions between urban ecosystems and biodiversity are multiplex, so do the relationship between urban humans and biodiversity-related concepts. While urban residents' demand for wildlife products is one of the major causes of biodiversity loss, the associations between biodiversity-related concepts and humans urban ecosystem need further research to not only improve urban people's quality of life and education but also facilitate biodiversity preservation and conservation. The current data descriptor, thus, presents a data set of multifaceted interactions between urban residents and biodiversity-related concepts in Vietnam–a highly urbanized developing country with a rich biodiversity level. Specifically, the data set is valuable for studying urban people's wildlife product consumption behaviors, perceptions, and interactions with biodiversity across different levels (individual, home, neighborhood, and public park), and nature-based recreation demand.

To reduce the biodiversity loss rate, the Vietnamese government has demonstrated a great commitment to biodiversity protection and conservation by implementing national strategic plans, programs, and initiatives [5]. Conservation of ecosystems, endangered, rare, and precious species and genetics is one of the government's main objectives. In particular, the government released *Decree 32/2006/ND-CP* and *Decree 82/2006/ND-CP* to prohibit harvest, trade, use, and consumption of all protected species [6]. However, efforts controlling the supply side in the wildlife trade network seem to be ineffective due to several reasons [7, 8]: 1) slow and inadequate law enforcement and policy implementation, 2) lacking resources for monitoring and management, such as manpower, funding, and equipment, 3) corruption among influential people, 4) conflicts of conservation initiatives and programs with local livelihoods, and 5) the increasingly organized and expanded criminal networks.

Given these challenges, many scientists have suggested paying more attention to tackling the wildlife consumption demand, particularly among the middle class in urban areas. The consumption of wildlife products in Vietnamese urban areas is prevalent with multiple purposes, such as traditional medicines (tiger bones, bear bile, etc.) [9, 10], wildmeat [11, 12], and petting [13], but legal mechanisms are still missing [12]. Social marketing campaigns have also been suggested as a potential method to reduce the consumption demand of wildlife products or redirect it to herbal substitutes [6, 14, 15]. Understanding how biodiversity perceptions influence wildlife product consumption behaviors can help improve the effectiveness of public communication and law implementation in urban areas.

Biodiversity-friendly environments are inextricably associated with sustainable urban concepts and human well-being [16], as they provide a wide range of provision and cultural ecosystem services, maintain human's connection to nature, increase aesthetic appreciation and inspiration, and improve physical and mental health [17, 18, 19]. Given such benefits of biodiversity, international organizations and scholars call for the conservation and preservation of biodiversity in cities for the sake of sustainability. For example, the Intergovernmental Panel on Biodiversity and Ecosystem Services and the United Nations Habitat call to integrate biodiversity notions into human settlements [20, 21]. Opoku suggests that biodiversity conservation needs to be an integral component of the built environment's policies and strategies towards sustainable development [22]. Recognizing urban residents' perceptions and interactions with biodiversity is vital to gain public acceptance and support in developing biodiverse urban environments, specifically in residential areas and public parks [23, 24].

Nature-based recreation is another notion in which biodiversity-related concepts and urban residents can be closely linked together. Nature-based recreation is defined as "all forms of leisure that rely on the natural environment" [25]. As "nature" refers to any outdoor areas with greenery or natural features, the urban residents' demand for nature-based recreation can be met through urban green spaces (e.g., public parks, gardens, or neighborhood) and protected area visitations [26]. Urban public parks are cohabitation places between city dwellers and nature, whereas protected areas are designated for conservation and nature-based tourism. The high biodiversity levels in urban public parks and protected areas positively influence the visitors' psychological well-being [19, 26, 27, 28]. In return, the increasing demand for nature-based recreation might generate sustainable finance for biodiversity conservation in protected areas and preservation in urban public parks [29, 30]. In particular, it is reported that urban residents in Mekong Delta are willing to pay around $11 million per year for biodiversity conservation activities in the nearby protected area [31]. Comprehending how urban residents' perceptions of biodiversity are linked to their visitation behaviors, motivations, and financial contribution can enhance monitoring, management, and regulation effectiveness in urban green spaces and protected areas.

Given the above reasons and the lack of related studies and resources in a developing country like Vietnam, data of urban residents' biodiversity perceptions and biodiversity-related behaviors are necessary. The current data descriptor provides a detailed explanation for the data set of wildlife consumption behaviors, multifaceted perceptions and interactions with biodiversity-related concepts, and nature-based recreation demand among urban Vietnamese residents. The data set comprises six major categories: 1) wildlife product consumption, 2) general biodiversity perceptions, 3) biodiversity at home and neighborhood, 4) public park visitation and motivations, 5) national park visitation and motivations, and 6) socio-demographic profiles. Such valuable resources are expected to enable studies about the human-biodiversity interactions in multiple aspects and provide insights for conservation and urban development policymaking, monitoring, management, and regulation.

2. METHODOLOGY

2.1 Survey Design and Validation

The survey was systematically designed with five major steps: (1) questionnaire design, (2) survey collection, (3) data check and validation, (4) data set generation, and (5) data analysis.

First, as there is a lack of qualitative research on biodiversity perceptions among Vietnamese urban people, an in-depth semi-structured interview was conducted to set the stage for questionnaire design. Specifically, 38 urban residents at the two largest cities (Ho Chi Minh City and Hanoi Capital City) in Vietnam were interviewed from November 15 to December 26, 2020. The interviewees were purposively chosen to diversify opinions according to their gender, age, occupations, and prior experiences with nature. When the "theoretical saturation" point was met, the interview was stopped [32]. Based on the interviewed results, the questionnaire was constructed with the six major categories.

1. Wildlife product consumption
2. General biodiversity perceptions
3. Biodiversity at home and neighborhood
4. Public park visitation and motivations
5. National park visitation and motivations
6. Socio-demographic profiles

The data were collected through a Web-based survey via Google Forms using a snowball sampling strategy. Google Forms was employed due to its user-friendly interfaces, confidentiality, and easy distribution [33]. The collection happened approximately two months, from June 18 to August 8, 2021. Even though the distribution was targeted at people living in Ho Chi Minh City and Hanoi Capital City, several respondents from other provinces and cities also participated in the survey. At the beginning of the questionnaire, respondents were required to read and agree with the consent form, which stipulates the research purposes, questionnaire contents, and confidentiality of participants. Two hundred random participants who completed the questionnaire were given a gift card with a value ranging from US $1 to US $10 through their email addresses. Eventually, 581 people got involved in the data collection.

Next, to ensure the data set quality, a four-step quality check was performed. First of all, a certain number of questionnaire respondents were from other provinces that were not urban, so their responses were excluded from the data set based on the residency they reported. Secondly, children whose age was less than 18-year-old were also excluded from the data set as their agreement to the consent form was not legitimate without guardians' acceptance. Thirdly, based on the reported email addresses, duplicate responses were detected and removed afterwards.

Finally, "straightlining" and "select-all" behavior can distort the analysis results [34], so any respondents giving identical answers to a set of questions using the same response scale and selecting all answers of checkbox questions simultaneously were excluded. Although responses with solely "straightline" answers were not excluded, they were marked "warning" in the *Quality Assessment* column at the end of the data

set. In detail, 27 responses were removed due to inappropriate residency; 13 were removed due to insufficient age; three were removed due to repeated reporting; three were removed due to their simultaneous "straightlining" and "select-all" behaviors. Eventually, 535 responses were included in the cleaned data set.

All four steps of the quality check were completed in the Microsoft Excel spreadsheet (xls.) file downloaded from Google Form. After cleaning the data, all the responses were encoded and saved under comma-separated value format for easing later uses. During this step, any missing data were coded as "NA" (a.k.a "Not Applicable"). The data set would be validated using Bayesian analysis in the later section.

2.2 Data Sample

Most respondents were from the two largest cities in Vietnam: 347 people from Ho Chi Minh City (accounting for 64.86%) and 107 people from Hanoi Capital City (accounting for 20%). The remaining respondents (15.14%) came from other urban areas, like Hue city, Vung Tau city, and Thanh Hoa city. Among 535 responses, female participants constituted a greater proportion than male participants (58.31% of females *versus* 41.12% of males). The average mean age of all participants was around 33.80. The educational level of participants was relatively high, as 85.05% of them acquired an undergraduate (63.18%) or post-graduate levels (21.87%).

The occupational backgrounds of participants were highly diverse, ranging from accountant, activist, actor to retiree and employee. The income of most participants (39.24%) fell into the range from 5 million to 15 million VNĐ monthly. No-income participants consisted of 4.11% of the total number, whereas the percentage of participants acquiring more than 30 million VNĐ monthly was 7.48%. Most of the participants reported spending the majority of their lifetime living in urban areas (84.86%). Only 54 and 26 participants spent most of their lifetime in sub-urban (10.09%) and rural areas (4.86%), respectively.

2.3 Response Coding

The current section presents how the responses of six major categories were coded according to the following order: 1) wildlife product consumption, 2) general biodiversity perceptions, 3) biodiversity at home and neighborhood, 4) public park visitation and motivations, 5) national park visitation and motivations, and 6) socio-demographic profiles. Two main types of responses are categorical (including binary variables) and numerical variables. In the next sub-sections, categorical variables are described using seven kinds of information corresponding with seven columns: "Variable", "Name", "Explanation", "Level", "Code", "Frequency", and "Proportion". Meanwhile, for the description of numerical variables, the last three columns are replaced with "Range", "Mean", and "Standard deviation".

2.3.1 Wildlife Product Consumption

The first sub-section of the data set comprises 12 categorical variables that demonstrate the wildlife product consumption behaviors among urban residents (Table 1). The variables were generated by questions

about four ways of consuming wildlife products: bushmeat, traditional medicine, products made from animal skin/fur/leather, and uncommon pet. Variables *A1* and *A2* are used to present whether the respondent has ever consumed bushmeat and their consumption frequency.

The behaviors of consuming traditional medicines made from wildlife are indicated by variables *A3_1* to *A5*. While variables *A3_1* to *A3_3* are whether the respondent has ever consumed animal bones, bile bear, and pangolin scale for medical treatment, the other two variables (*A4* and *A5*) are the respondent's information sources of traditional medicine and perception of effective medicine. Animal bones, bile bear, and pangolin scale are three frequently consumed materials for traditional medicines in Vietnam [9, 10, 35].

The consumption behaviors of products made from animal skin/fur/leather are indicated by variables *A6* to *A8*. The remaining two variables are to demonstrate the uncommon pet adoption behaviors of the respondent. Uncommon pets are animals that are not dogs or cats.

Table 1. Description of variables related to wildlife product consumption.

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
A1	Bushmeat consumption	Whether the respondent has ever consumed bushmeat	Yes	1	202	37.76%
			No	0	333	62.24%
A2	Bushmeat consumption frequency	How often the respondent consumes bushmeat	Never	1	345	64.49%
			Sometimes	2	188	35.14%
			Often	3	1	0.19%
			Very often	4	1	0.19%
A3_1	Animal bone consumption	Whether the respondent has ever consumed animal bone (monkey, tiger, horse, etc.) for traditional medicine	Yes	1	77	14.39%
			No	0	458	85.61%
A3_2	Bile bear consumption	Whether the respondent has ever consumed bile bear for traditional medicine	Yes	1	116	21.68%
			No	0	419	78.32%
A3_3	Pangolin scale consumption	Whether the respondent has ever consumed pangolin scale for traditional medicine	Yes	1	11	2.06%
			No	0	524	97.94%
A4	Information source of traditional medicine	Information sources for traditional medicine	Family and friends	a	321	60.00%
			Newspaper	b	270	50.47%
			Social media	c	359	67.10%
			Book	d	112	20.93%
			Doctor	e	31	5.79%
			Other	f	7	1.31%
A5	Perceived effective medicine	Perceived effective type of medicine	Eastern medicine	1	64	11.96%
			Same	2	219	40.93%
			Western medicine	3	252	47.10%

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
A6	Skin/fur/leather product consumption	Whether the respondent likes consuming animal skin/fur/leather	No, I don't	1	449	83.93%
			Yes, a little	2	76	14.21%
			Yes, a lot	3	10	1.87%
A7	Number of skin/fur/leather product	The number of products made from animal skin/fur/leather that the respondent owns	Nothing	1	429	80.19%
			1-3 products	2	95	17.76%
			3-5 products	3	4	0.75%
			More than 5 products	4	7	1.31%
A8	Skin/fur/leather product consumption	Whether the respondent owns any products made from animal skin/fur/leather	Yes	1	106	19.81%
			No	0	429	80.19%
A9	Interest in uncommon pet	Whether the respondent likes owning uncommon pet	No, I don't	1	363	67.85%
			Yes, a little	2	142	26.54%
			Yes, a lot	3	30	5.61%
A10	Uncommon pet adoption	Whether the respondent has ever adopted any uncommon pet	No, never	1	401	74.95%
			Yes, in the past	2	116	21.68%
			Yes, I'm adopting now	3	18	3.36%

2.3.2 *General Biodiversity Perceptions*

The second sub-section focuses on the urban residents' general perceptions towards biodiversity, like the self-assessment knowledge (variable *B1*), perceived importance of biodiversity loss (variable *B2*), perceived consequences of biodiversity loss (variables *B3_1* to *B3_13*), perceived preventive measures of biodiversity loss (variables *B4_1* to *B4_9*), perceived biodiversity-affected objects (variables *B5_1* to *B5_4*), and perceived contributors to biodiversity loss prevention (variables *B6_1* to *B6_5*). In total, 33 variables belong to this group (Table 2).

Table 2. Description of variables related to general biodiversity perceptions.

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
B1	Biodiversity knowledge	Self-assessment knowledge about biodiversity	Never heard about	1	64	11.96%
			Poor	2	189	35.33%
			Adequate	3	243	45.42%
			Good	4	39	7.29%
B2	Biodiversity perception	Perception about the importance of biodiversity loss	Biodiversity loss is not real	1	17	3.18%
			Biodiversity loss is real but only a small problem	2	30	5.61%
			Biodiversity loss is real and a major environmental problem	3	488	91.21%

Numerical variables					
Variable	Name	Explanation	Range	Mean	SD
B3_1	Perceived impact [pollution]	Agreement with that the following consequence is a result of biodiversity loss [Environmental pollution (air pollution, water pollution, etc.)]	1. Strongly disagree 2. Disagree 3. Agree 4. Strongly agree	3.34	0.74
B3_2	Perceived impact [climate change]	Agreement with that the following consequence is a result of biodiversity loss [Climate change]		3.33	0.72
B3_3	Perceived impact [life imbalance]	Agreement with that the following consequence is a result of biodiversity loss [Loss of life balance]		3.17	0.76
B3_4	Perceived impact [good's diversity loss]	Agreement with that the following consequence is a result of biodiversity loss [Loss of daily product variety (food, medicine, etc.)]		2.95	0.84
B3_5	Perceived impact [economic growth]	Agreement with that the following consequence is a result of biodiversity loss [Negative impacts on economic growth]		2.85	0.83
B3_6	Perceived impact [green space]	Agreement with that the following consequence is a result of biodiversity loss [Loss of green space]		3.34	0.72
B3_7	Perceived impact [natural scenery]	Agreement with that the following consequence is a result of biodiversity loss [Loss of natural aesthetics]		3.35	0.72
B3_8	Perceived impact [nature-based recreation]	Agreement with that the following consequence is a result of biodiversity loss [Loss of opportunities for nature-based recreation]		3.02	0.80
B3_9	Perceived impact [knowledge loss]	Agreement with that the following consequence is a result of biodiversity loss [Loss of knowledge about nature]		3.15	0.81
B3_10	Perceived impact [life quality loss]	Agreement with that the following consequence is a result of biodiversity loss [Reduction of quality of life]		3.14	0.76
B3_11	Perceived impact [physical health loss]	Agreement with that the following consequence is a result of biodiversity loss [Reduction of physical health]		3.00	0.81
B3_12	Perceived impact [mental health loss]	Agreement with that the following consequence is a result of biodiversity loss [Reduction of mental health]		3.04	0.78
B3_13	Perceived impact [life expectancy loss]	Agreement with that the following consequence is a result of biodiversity loss [Reduction of life expectancy]		2.95	0.82

Numerical variables					
Variable	Name	Explanation	Range	Mean	SD
B4_1	Perceived prevention method [conservation]	Agreement with that the following measure is preventive of biodiversity loss [Species conservation in protected areas]	1. Strongly disagree 2. Disagree 3. Agree 4. Strongly agree	3.36	0.72
B4_2	Perceived prevention method [reduction of deforestation and exploitation]	Agreement with that the following measure is preventive of biodiversity loss [Reduction of deforestation and exploitation]		3.60	0.67
B4_3	Perceived prevention method [environmental law]	Agreement with that the following measure is preventive of biodiversity loss [Environmental law enactment]		3.54	0.65
B4_4	Perceived prevention method [research]	Agreement with that the following measure is preventive of biodiversity loss [Scientific research]		3.30	0.68
B4_5	Perceived prevention method [public communication]	Agreement with that the following measure is preventive of biodiversity loss [Public communication about biodiversity (loss)]		3.48	0.67
B4_6	Perceived prevention method [education]	Agreement with that the following measure is preventive of biodiversity loss [Education about biodiversity (loss)]		3.48	0.67
B4_7	Perceived prevention method [wildlife consumption prohibition]	Agreement with that the following measure is preventive of biodiversity loss [Prohibition of illegal wildlife consumption]		3.60	0.67
B4_8	Perceived prevention method [environmental tax]	Agreement with that the following measure is preventive of biodiversity loss [Environmental tax]		3.24	0.77
B4_9	Perceived prevention method [donation]	Agreement with that the following measure is preventive of biodiversity loss [Donation for biodiversity conservation]		3.25	0.73
B5_1	Affected object [my life]	Agreement with that the following object is affected by biodiversity loss [My life]	1. Strongly disagree 2. Disagree 3. Agree 4. Strongly agree	3.06	0.69
B5_2	Affected object [my family]	Agreement with that the following object is affected by biodiversity loss [My family]		3.03	0.70
B5_3	Affected object [my neighborhood]	Agreement with that the following object is affected by biodiversity loss [My neighborhood]		3.14	0.67
B5_4	Affected object [my city]	Agreement with that the following object is affected by biodiversity loss [My city]		3.23	0.67

Numerical variables					
Variable	Name	Explanation	Range	Mean	SD
B6_1	Contributor [myself]	Agreement with that the following subject can contribute to biodiversity loss prevention [Myself]	1. Strongly disagree 2. Disagree 3. Agree 4. Strongly agree	3.30	0.62
B6_2	Contributor [my family]	Agreement with that the following subject can contribute to biodiversity loss prevention [My family]		3.27	0.62
B6_3	Contributor [my neighbors]	Agreement with that the following subject can contribute to biodiversity loss prevention [People in my neighborhood]		3.29	0.62
B6_4	Contributor [government]	Agreement with that the following subject can contribute to biodiversity loss prevention [Government]		3.53	0.65
B6_5	Contributor [international organization]	Agreement with that the following subject can contribute to biodiversity loss prevention [International organization]		3.55	0.64

2.3.3 *Biodiversity at Home and Neighborhood*

The third sub-section focuses on the interactions between humans and biodiversity at the respondent's home and neighborhood (Table 3). The first four variables (from *C1_1* to *C1_4*) show the respondent's behaviors and willingness to plant varied types of plants in their houses, while the next four variables (from *C2_1* to *C2_4*) present the respondent's behaviors and willingness of adopting varied types of pet in their houses. The respondent's feelings (e.g., comfortability and aesthetics) when being in the house are indicated by variables *C3_1* to *C3_4*. The last three variables (*C4_1*, *C4_2*, and *C4_3*) are used to present the perceived availability of plants in the respondent's neighborhood, their willingness to donate to a planting project, and considered important aspects of the project, respectively.

Table 3. Description of variables related to biodiversity at home and neighborhood.

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
C1_1	In-house planting (scale)	Whether the respondent plants plant in their house	Not at all	1	31	5.79%
			Yes, but only a few	2	292	54.58%
			Yes, I plant many	3	212	39.63%
C1_2	In-house planting (binary)	Whether the respondent plants plant in their house	Yes	1	504	94.21%
			No	0	31	5.79%
C1_3	Number of types of plants planted	The number of types of plants planted in the house	0	0	30	5.61%
			1	1	17	3.18%
			2	2	48	8.97%
			3	3	66	12.34%
			4	4	32	5.98%
			5	5	50	9.35%
			More than 5	6	292	54.58%

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
C1_4	Willingness to plant more plants	Whether the respondent is willing to plant more plants	No, I wouldn't	1	38	7.10%
			Yes, I would plant more plants from the same type	2	49	9.16%
			Yes, I would plant more plants from various types	3	448	83.74%
C2_1	Petting	Whether the respondent owns any pet	Yes	1	254	47.48%
			No	0	281	52.52%
C2_2	Type of pet	Type of pet that the respondent owns	Cat	a	142	26.54%
			Dog	b	225	42.06%
			Fish	c	174	32.52%
			Other	d	23	4.30%
			No pet	e	154	28.79%
C2_3	Number of pets	Number of pet types that the respondent owns	0	0	200	37.38%
			1	1	183	34.21%
			2	2	70	13.08%
			More than 2	3	62	11.59%
C2_4	Willingness to adopt more pet	Whether the respondent is willing to adopt more pet	No, I wouldn't	1	347	64.86%
			Yes, I would adopt more pets from the same type	2	78	14.58%
			Yes, I would adopt more pets from various types	3	110	20.56%
C3_1	Feeling comfortable at home (scale)	How much comfortable the respondent feels in the house	Very Uncomfortable	1	25	4.67%
			Uncomfortable	2	33	6.17%
			Comfortable	3	258	48.22%
			Very comfortable	4	219	40.93%
C3_2	Feeling comfortable at home (binary)	Whether the respondent feels comfortable when being in the house	Comfortable	1	477	89.16%
			Uncomfortable	0	58	10.84%
C3_3	Feeling aesthetic at home due to plant/animal (scale)	How much aesthetic the respondent feels the house is due to plant/animal	Very negative effect	1	12	2.24%
			Negative effect	2	12	2.24%
			Positive effect	3	316	59.07%
			Very positive effect	4	195	36.45%
C3_4	Feeling aesthetic at home due to plant/animal (binary)	Whether the respondent feels the house aesthetic due to plant/animal	Positive effect	1	511	95.51%
			Negative effect	0	24	4.49%
C4_1	Plants in the neighborhood	Whether there are any plants in the neighborhood	Not at all	1	26	4.86%
			A few	2	232	43.36%
			Many	3	188	35.14%
			Abundant	4	89	16.64%
C4_2	Donation to planting project in the neighborhood	Whether the respondent is willing to financially contribute to the planting project in the neighborhood	Not at all	1	5	0.93%
			Not really	2	60	11.21%
			Willing	3	284	53.08%
			Very willing	4	186	34.77%

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
C4_3	Favorable planting characteristics in the neighborhood	Important aspects that should be considered in the planting project	Amount	a	248	46.36%
			Variety	b	267	49.91%
			Aesthetics	c	388	72.52%
			Location	d	323	60.37%
			Utilities (shades, etc.)	e	365	68.22%
			Other	f	5	0.93%

2.3.4 Public Park Visitation and Motivations

Respondent's public park visitation and involvement in planting projects can be explored using the variables in the fourth sub-section (Table 4). At the beginning of the sub-section, the question, "is there any public park near your house?" was asked. If the respondent answered "yes", other questions about their visitation to the public park and planting-project contribution willingness would be given. Otherwise, these questions would be skipped. In this sub-section, specific questions about the public park's biodiversity characteristics were not included to avoid respondent's recall bias, which downgrades the answers' reliability.

Table 4. Description of variables related to public park visitation and motivations.

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
D1	Availability of a nearby public park	Whether there is a public park near where the respondent lives	Yes	1	415	77.57%
			No	0	120	22.43%
D2	Public park visitation frequency	Frequency of going to the nearby public park	Never	1	21	3.93%
			Almost never	2	38	7.10%
			Sometimes	3	281	52.52%
			Almost everyday	4	55	10.28%
			Everyday	5	20	3.74%
D3	Public park visitation reasons	The respondent's reasons to visit the nearby public park	Relaxation	a	260	48.60%
			Physical activities	b	238	44.49%
			Meeting with friends	c	96	17.94%
			Spending time with family	d	107	20.00%
			Educational activities for children	e	101	18.88%
			Enjoying nature	f	220	41.12%
			Community events	g	70	13.08%
			Other	h	2	0.37%

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
D4	Donation to planting project in the public park	Whether the respondent is willing to financially contribute to the planting project in the nearby public park	Not at all	1	8	1.50%
			Not really	2	58	10.84%
			Willing	3	244	45.61%
			Very willing	4	105	19.63%
D5	Favorable planting characteristics in the public park	Important aspects that should be considered in the planting project	Amount	a	220	41.12%
			Variety	b	281	52.52%
			Aesthetics	c	326	60.93%
			Location	d	228	42.62%
			Utilities (shades, etc.)	e	284	53.08%
			Other	f	7	1.31%

2.3.5 National Park Visitation and Motivations

The fifth sub-section is about the respondent's national park visitation (Table 5). Besides the visitation behaviors (variable *E1*) and motivations (variables *E2* to *E4*), the respondent's willingness that might contribute to conservation finance in national parks was also measured by variable *E5* (entrance fee payment willingness) and *E6* (donation willingness). The questions in this sub-section were kept as general (or not context-based) as possible because urban residents in different cities had distinct impression with particular national parks, so their perceptions about national parks might be different accordingly. Moreover, recall bias also alleviates the reliability of responses to specific (or context-based) questions.

Table 5. Description of variables related to national park visitation and motivations.

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
E1	National Park visitation frequency	Frequency of going to the national park	Never	1	114	21.31%
			Less than once a year	2	259	48.41%
			Once a year	3	111	20.75%
			Twice a year	4	27	5.05%
			More than twice a year	5	24	4.49%
E2	National park visitation reasons	The respondent's reasons to visit the national park	Escape and relaxation	a	300	56.07%
			Enjoying nature	b	342	63.93%
			Watching wild animals	c	290	54.21%
			Meeting with friends	d	107	20.00%
			Spending time with family	e	223	41.68%
			Educational activities for children	f	182	34.02%
			Seeking new knowledge (animals, plants, etc.)	g	244	45.61%
			Outdoor activities (hiking, trekking, etc.)	h	233	43.55%
			Other	i	7	1.31%

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
E3	Willingness to visit a national park (scale)	Whether the respondent is willing to visit a national park in the next 12 months	No, I don't even think about it	1	30	5.61%
			No, but maybe later	2	36	6.73%
			Yes, but I'm still not sure	3	232	43.36%
			Yes, certainly	4	237	44.30%
E4	Willingness to visit a national park (binary)	Whether the respondent is willing to visit a national park in the next 12 months	Yes	1	469	87.66%
			No	0	66	12.34%
E5	Entrance fee payment willingness	Whether the respondent is willing to pay for the national park's entrance fee	Yes	1	522	97.57%
			No	0	13	2.43%
E6	Conservation project donation willingness	Whether the respondent is willing to donate to the national park's conservation activities	Yes	1	508	94.95%
			No	0	27	5.05%

2.3.6 Socio-demographic Profile

The last sub-section consists of variables about the socio-demographic characteristics of the respondent, such as gender (variable *F1*), age (variables *F2* and *F3*), occupation (variable *F4*), educational level (variable *F5*), and income (variables *F6* and *F7*). Apart from basic information, the nearby landscape (variable *F8*), environmental information source (variable *F9*), most frequently lived area (variable *F10*), and current residency (variable *F11*) are also included in the sub-section (Table 6).

Table 6. Description of variables related to respondents' socio-demographic profiles.

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
F1	Gender	Gender	Female	0	312	57.08%
			Male	1	220	42.92%
F3	Age group	The age group in which the respondent belongs to	18–22	1	120	13.95%
			23–30	2	132	21.36%
			31–40	3	140	25.75%
			41–50	4	87	17.37%
			51–60	5	36	7.58%
			More than 60	6	20	3.99%
F4	Occupation	The current occupation of the respondent	NA	NA	NA	NA
F5	Education	The highest educational level of the respondent	Primary school	1	1	0.2%
			Secondary school	2	9	1.8%
			High school	3	70	13.77%
			Undergraduate	4	338	61.68%
			Post-graduate	5	117	22.55%

Categorical variables						
Variable	Name	Explanation	Level	Code	Frequency	Proportion
F7	Income group	The income group in which the respondent belongs to	No income	1	22	4.39%
			Less than 5 million VNĐ	2	53	10.58%
			10–15 million VNĐ	3	99	15.37%
			5–10 million VNĐ	4	107	20.16%
			15–20 VNĐ	5	40	7.78%
			20–30 million VNĐ	6	44	9.38%
			More than 30 million VNĐ	7	40	7.78%
F8	Nearby landscape	The landscapes that the respondent has ever lived nearby	Forest	a	121	23.15%
			Ocean	b	133	24.35%
			River	c	201	36.73%
			Cropland	d	205	37.72%
			Pond	e	203	37.92%
			Other	f	143	28.54%
			Not at all	g	6	0%
F9	Environmental information source	The sources from which the respondent receives environment-related information	Newspaper	a	382	71.86%
			Online newspaper	b	380	71.46%
			Social Media	c	464	87.03%
			Lecture	d	228	43.91%
			Word of mouth	e	278	52.50%
			Books	f	253	47.90%
			Textbooks	g	228	43.51%
			Documentary movies	h	339	64.27%
			Observations	i	292	56.09%
			Local government	j	99	19.56%
			Others	k	3	0.6%
F10	Area with most living time	The area in which the respondent has spent a majority of their lifetime	Urban	a	454	85.63%
			Sub-urban	b	54	10.38%
			Rural	c	26	3.79%
F11	Current residency	The current city in which the respondent is living	NA	NA	NA	NA

Numerical variable					
Variable	Name	Explanation	Range	Mean	SD
F2	Age	The reported age of the respondent	18-71	33.80	12.18
F5	Income	The reported income of the respondent	0-100,000,000	13,708,971	16,646,862

3. EXEMPLARY DATA ANALYSIS

This section presents Bayesian linear analysis's results to validate the data set. I constructed the model using four socio-demographic factors (*Gender*, Age, *Education*, and *Income*) and two perceptions about perceived impacts of biodiversity loss (*GoodDiversityLoss* and *EconomicGrowthLoss*) as predictor variables. The *Gender*, Age, *Education*, and *Income* variables were illustrated by *F1*, *F2, F5,* and *F7* variables in the data set. *B3_4* and *B3_5* variables correspondingly present the agreement level with that the loss results of daily product diversity and negative impacts on economic growth are consequences of biodiversity loss. Meanwhile, the respondents' agreement with prohibiting illegal wildlife consumption as a preventive measure was selected as the outcome variable, which variable *WildConsProhibi* exhibits. The variable was generated by modifying variable *B4_7* from numerical data to dichotomous data, with "strongly disagree" and "disagree" being 0 and "agree" and "strongly agree" being 1. Eventually, the constructed model and its logical network can be presented as follows (Figure 1):

$$WildConsProhibi \sim \alpha + Gender + Age + Education + Income + GoodDiversityLoss + EconomicGrowthLoss$$

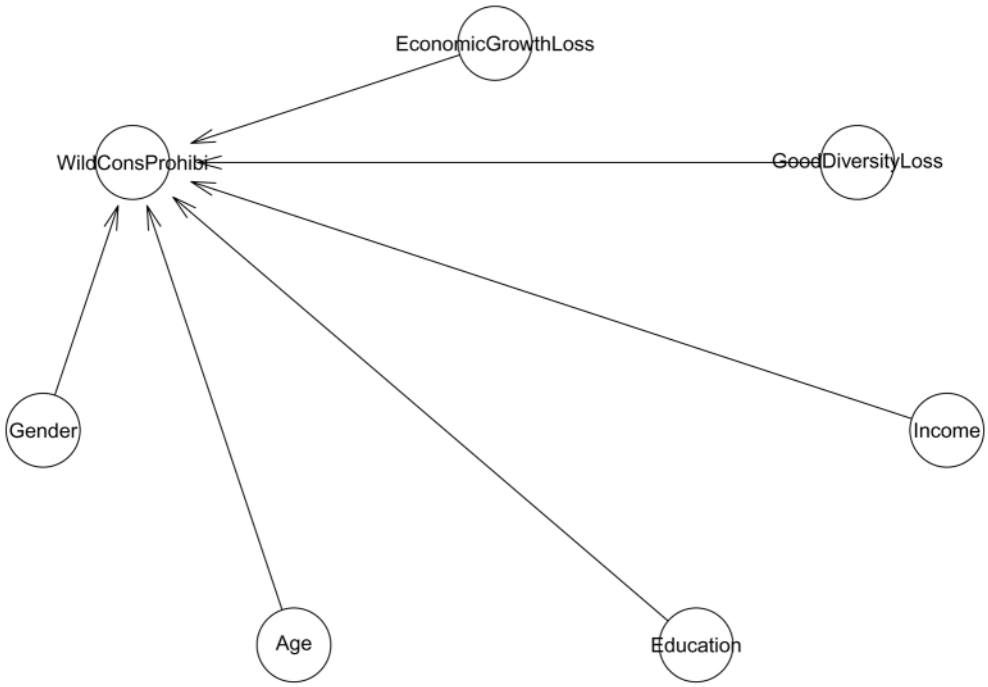

Figure 1. Logical network of the simulated model.

The bayesvl R package was utilized to perform the data analysis due to its user-friendly operation, eye-catching graphics, and integration of the Monte Carlo Markov Chain (MCMC) technique [36, 37]. All the parameters' prior distributions were set at normal distribution (0,10), or "uninformative" distribution. The simulation was operated on R Studio (version 4.1.0) using four Markov chains and 5,000 iterations, 2,000 of which were for the warm-up process. Before constructing and fitting the model in R, the following code snippet was employed to prepare necessary resources:

```
# Data preparation
data1<-read.csv("C:/Users/…/Data_535 (cleaned).csv", header = TRUE, stringsAsFactors = TRUE)

data1$WildConsProhibi<-data1$B4_7

data1$Gender<-data1$F1
data1$Age<-data1$F2
data1$Education<-data1$F5
data1$Income<-data1$F7

data1$GoodDiversityLoss<-data1$B3_4
data1$EconomicGrowthLoss<-data1$B3_5

require(dplyr)

data1$WildConsProhibi <-
 case_when(
   data1$WildConsProhibi %in% c("1","2") ~ 0,
   data1$WildConsProhibi %in% c("3","4") ~ 1
 )

keeps<-c("Gender","Age","Education","Income","WildConsProhibi","GoodDiversityLoss","EconomicGrowth
Loss")
data1<-data1[keeps]
data1<-na.omit(data1)

# Package loading
library(bayesvl)
library(cowplot)
```

Then, we started to construct and fit the model:

```
# Model construction
model<-bayesvl()
model<-bvl_addNode(model,"WildConsProhibi","binom")
model<-bvl_addNode(model,"Gender","binom")
model<-bvl_addNode(model,"Age","norm")
model<-bvl_addNode(model,"Education","norm")
model<-bvl_addNode(model,"Income","norm")
model<-bvl_addNode(model,"GoodDiversityLoss","norm")
model<-bvl_addNode(model,"EconomicGrowthLoss","norm")

model<-bvl_addArc(model,"Gender","WildConsProhibi","slope")
model<-bvl_addArc(model,"Age","WildConsProhibi","slope")
model<-bvl_addArc(model,"Education","WildConsProhibi","slope")
model<-bvl_addArc(model,"Income","WildConsProhibi","slope")
model<-bvl_addArc(model,"GoodDiversityLoss","WildConsProhibi","slope")
model<-bvl_addArc(model,"EconomicGrowthLoss","WildConsProhibi","slope")

# Stan code generation
model_string<-bvl_model2Stan(model)
cat(model_string)

# Model Fit
model<-bvl_modelFit(model, data1, warmup = 2000, iter = 5000, chains = 4,cores = 4)

summary(model)
```

The simulated results are shown in Table 7. When employing Bayesian analysis, diagnosing the convergence of Markov chains is one of the fundamental steps. The diagnosis can be performed using two basic statistics: effective number size (n_eff) and Gelman shrink factor (Rhat). If the n_eff value is larger than 1,000 and the Rhat value equals 1, the model's Markov chains can be deemed well-convergent, and the estimations are reliable. Here, all the parameters' n_eff and Rhat values meet the basic criteria.

Table 7. Estimated posterior coefficients.

Parameters	Mean (μ)	Standard deviation (σ)	n_eff	Rhat
Constant	-4.36	2.11	6241	1
Gender	0.78	0.65	7921	1
Age	0.00	0.03	8647	1
Education	0.63	0.42	7153	1
Income	0.15	0.25	6942	1
GoodDiversityLoss	0.87	0.44	7121	1
EconomicGrowthLoss	0.98	0.46	7152	1

Using the diagnostic statistics solely is not sufficient, but visual diagnoses through trace plots, Gelman plots, and autocorrelation plots are also required. The trace plots in Figure 2 show "healthy" and stationary patterns of Markov chains, so the convergence can be confirmed. In the Gelman plots, the shrink factor values drop rapidly to 1 during the warm-up period (before the 2,000th iterations), while the autocorrelation levels in autocorrelation plots also decline to 0 after a certain lag (Figures A1 and A2). Both signals indicated by Gelman and autocorrelation plots imply that the Markov chain central limit theorem is held, so the simulated results are reliable for interpretation.

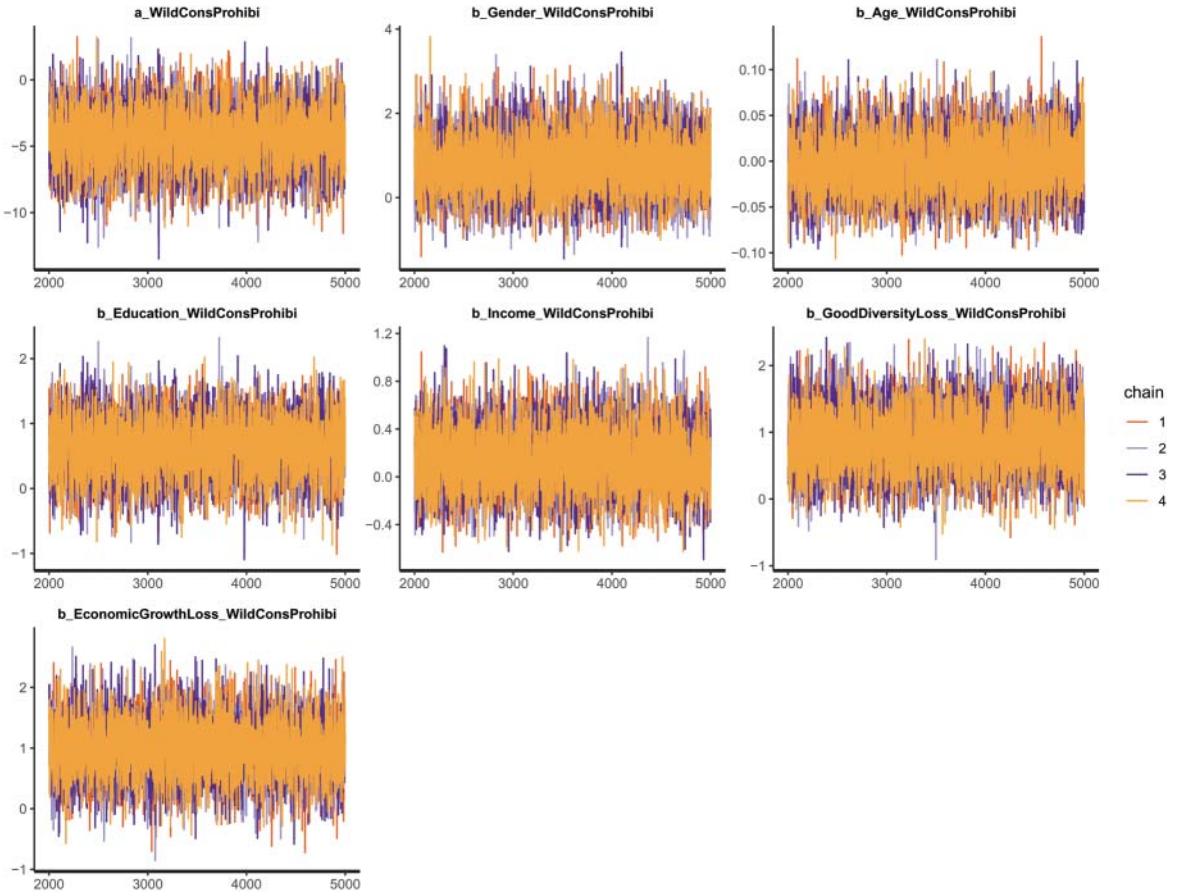

Figure 2. Trace plots.

The simulated results show that *Gender*, *Education*, and *Income* positively influenced the probability to agree that illegal wildlife consumption prohibition is a preventive measure of biodiversity loss (μ_{Gender} = 0.78 and σ_{Gender} = 0.65; $\mu_{Education}$ = 0.63 and $\sigma_{Education}$ = 0.42; μ_{Income} = 0.0.15 and σ_{Income} = 0.25), but *Age* did not (μ_{Age} = 0.00 and μ_{Age} = 0.03). When plotting the probability distributions of parameters, we could see that almost entire distributions of *Gender* and *Education* are located on the positive side of the *x*-axis, indicating reliable positive associations among *Gender*, *Education*, and *WildConsProhibi*.

As for *Income*, the certain proportion of the distribution still lies on the negative side, so its positive association with *WildConsProhibi* was less reliable than the other two.

Apart from socio-demographic factors, I also found positive associations between perceptions about the consequences of biodiversity loss and the agreement that wildlife consumption prohibition is a preventive measure. Specifically, respondents thinking that the loss of daily product variety and loss of economic growth are consequences of biodiversity loss were more likely to consider wildlife consumption prohibition a preventive measure ($\mu_{GoodDiversityLoss}$ = 0.87 and $\sigma_{GoodDiversityLoss}$ = 0.44; $\mu_{EconomicGrowthLoss}$ = 0.98 and $\sigma_{EconomicGrowthLoss}$ = 0.46). In Figures 3A and 3B, their probability distributions are almost completely located on the positive side of the *x*-axis, implying the high reliability of the associations.

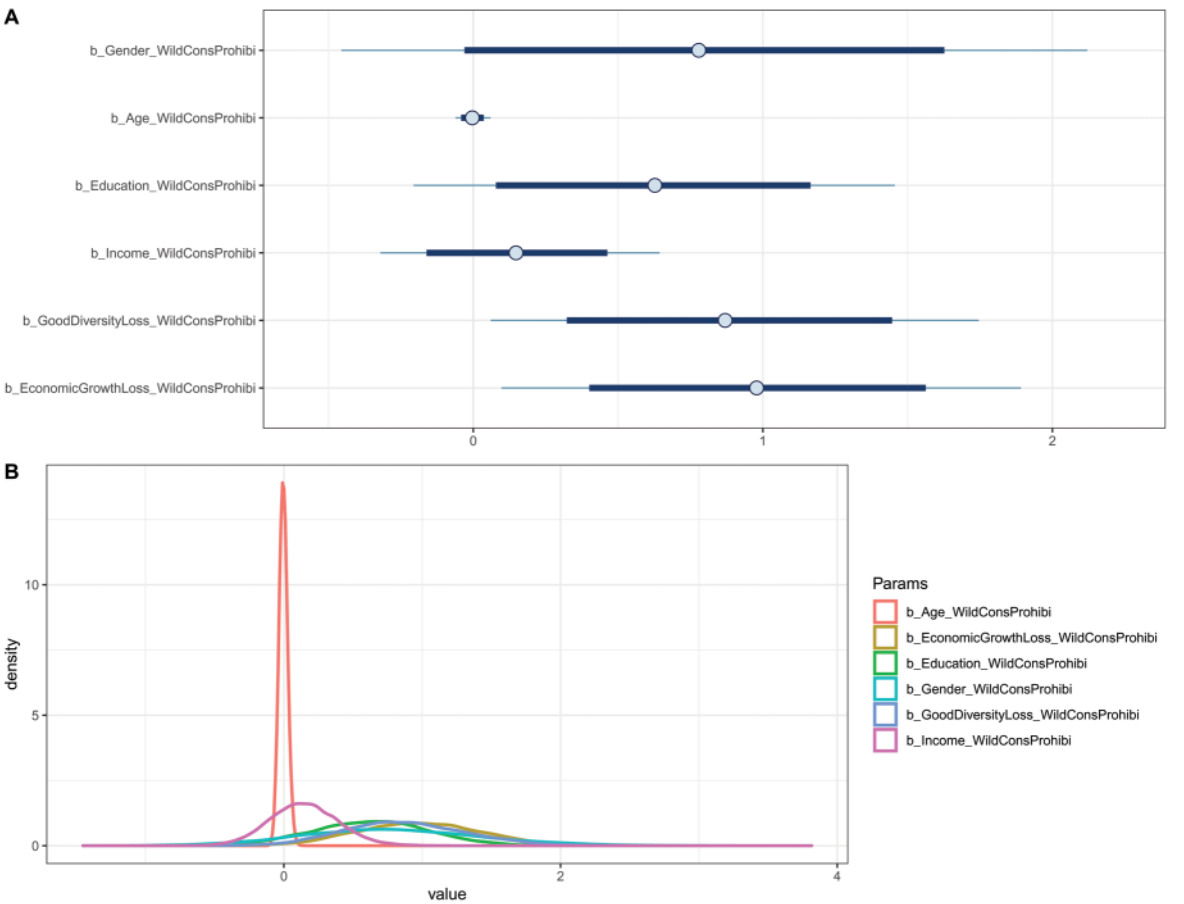

Figure 3. Probability distributions of posterior coefficients (**A**–Interval plot, **B**–Density plot).

For plotting the above figures, the following code snippet was used:

```
# Figure 1 visualization
bvl_bnPlot(model)

# Figure 2 visualization
bvl_plotTrace(model)

# Figure A1 visualization
bvl_plotGelmans(model,NULL,3,3)

# Figure A2 visualization
bvl_plotAcfs(model,NULL,3,3)

# Figures 3A and 3B visualization
Distribution_1<-bvl_plotIntervals(model,c("b_Gender_WildConsProhibi","b_Age_WildConsProhibi","
b_Education_WildConsProhibi","b_Income_WildConsProhibi","b_GoodDiversityLoss_WildConsProhibi","
b_EconomicGrowthLoss_WildConsProhibi"))+theme_bw()

Distribution_2<-bvl_plotDensity(model,c("b_Gender_WildConsProhibi","b_Age_WildConsProhibi","
b_Education_WildConsProhibi","b_Income_WildConsProhibi","b_GoodDiversityLoss_WildConsProhibi","
b_EconomicGrowthLoss_WildConsProhibi"))+theme_bw()

plot_grid(Distribution_1,Distribution_2,nrow = 2,labels = c('A','B'))
```

4. USAGE NOTES AND CONCLUSION

The current data set provides resources for studying important aspects of the interactions between urban residents and biodiversity-related concepts, which are currently lacking in the literature.

Besides the stringent quality-check process, the data set was also employed to examine the associations between the agreement with illegal wildlife consumption and perceived negative impacts of biodiversity loss for further validation. The results show that respondents who perceived more negative effects of biodiversity on economic growth and their daily used product diversity would be more likely to agree with illegal wildlife consumption prohibition. This finding is aligned with the Mindsponge mechanism, which stipulates that an individual's perceptions towards a specific matter are influenced by their subjective cost-benefit judgement towards that matter [38, 39, 40]. Due to the consistency with the theoretical assumption, the data set can be deemed reliable to study the socio-psychological aspects of the relationship between urban humans and biodiversity-related concepts.

Some potential issues can be explored using the current data set. First of all, mitigating the demand for the wildlife product among urban residents is crucial for biodiversity loss reduction. Raising urban residents' awareness through social marketing campaigns is a potential measure to achieve such a target [6, 7]. Using the current data set to explore how biodiversity perceptions influence wildlife product consumption

behaviors might help improve the effectiveness and efficiency of public communication campaigns and programs. Besides, insights generated from this data set might also contribute to the biodiversity conservation-related legislation and law enforcement in urban areas [12].

Secondly, based on the current data set, researchers can also investigate the interactions of urban residents with biodiversity-related concepts in multiple green spaces at home, neighborhood, urban public park, and national park. This can help enrich the literature in both sustainable urban development and biodiversity conservation. For example, planting and pet keeping behaviors might be associated with the willingness to support planting projects in the neighborhood and public parks. Moreover, the frequency of visiting national parks might be predicted by the biodiversity perceptions of urban residents, which provides more insights for social marketing campaigns to attract more visitors. The increasing influx of visitors might help generate sustainable finance for biodiversity conservation in national parks and preservation in urban public parks [29, 30].

Additionally, the current data set helps reduce the cost of doing science for researchers in developing countries with similar characteristics to Vietnam [41]: high urbanization rate and high level of biodiversity (e.g., being located in a biodiversity hotspot). Within an academic setting with high competition and limited resources, not only researchers from developing countries, but also young scholars in developed countries can capitalize on this data set to develop new hypotheses and test their assumptions regarding the relationships between urban humans and biodiversity-related concepts [42]. Making the data set open also enhances transparency and facilitates open review and dialogue among researchers [43].

In summary, the data set was systematically designed, collected, and validated to explore the interactions between urban residents and biodiversity-related concepts. Thus, researchers can make use of the data set to enrich the lax literature regarding the role of urban residents in biodiversity conservation and preservation; policymakers can find insights for building up an "eco-surplus culture" [44] among urban residents through effective public communication and policymaking.

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CONFLICT OF INTEREST

The data set was designed and collected for the author's dissertation research project.

DATA AVAILABILITY STATEMENT

The responses of 535 participants on the multifaceted interactions between urban humans and biodiversity were saved as "Data_535 (cleaned).csv" and deposited in Science Data Bank repository, https://doi.org/10.11922/sciencedb.j00104.00097, under an Attribution 4.0 International (CC BY 4.0). Detailed data description, which was saved as "Data description.xlsx", was also included in the same repository. All information related to participants' personal contacts was excluded for the sake of confidentiality.

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APPENDIX A

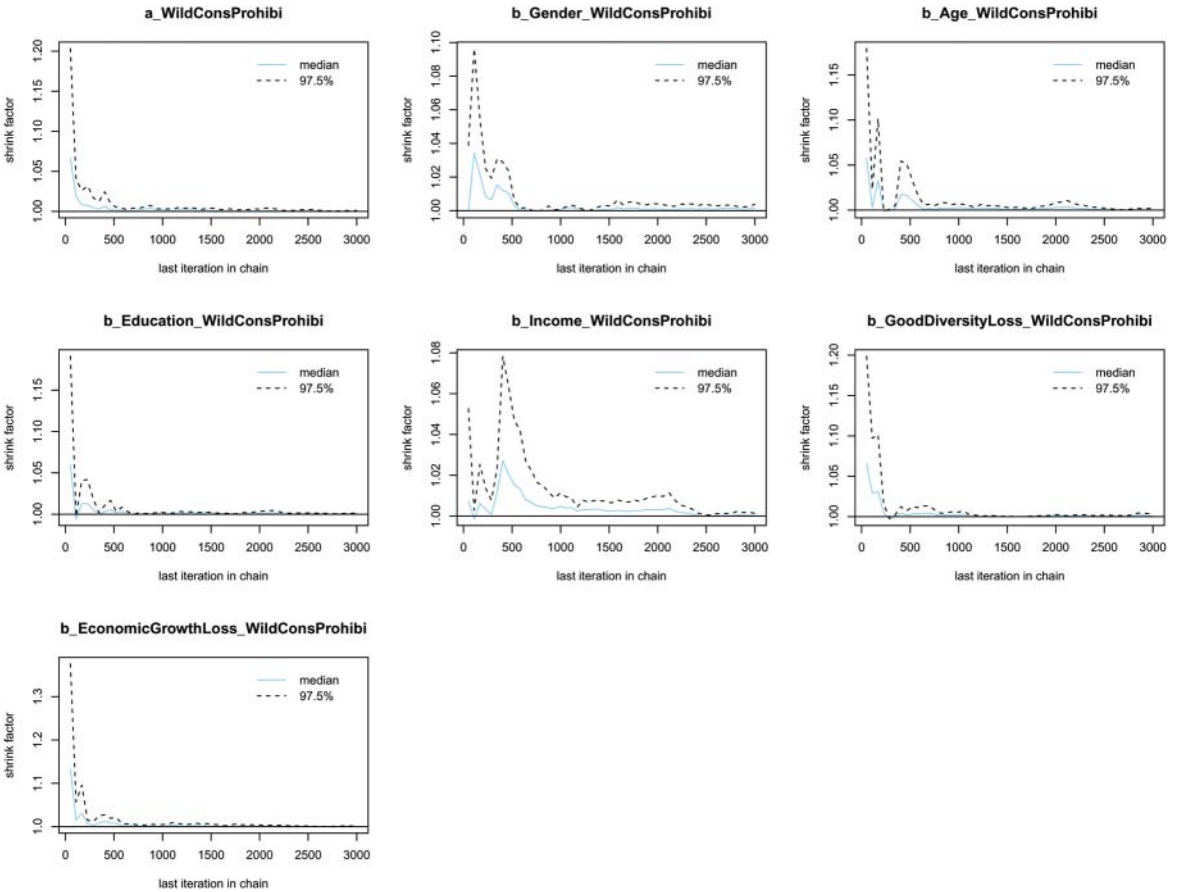

Figure A1. Gelman plots.

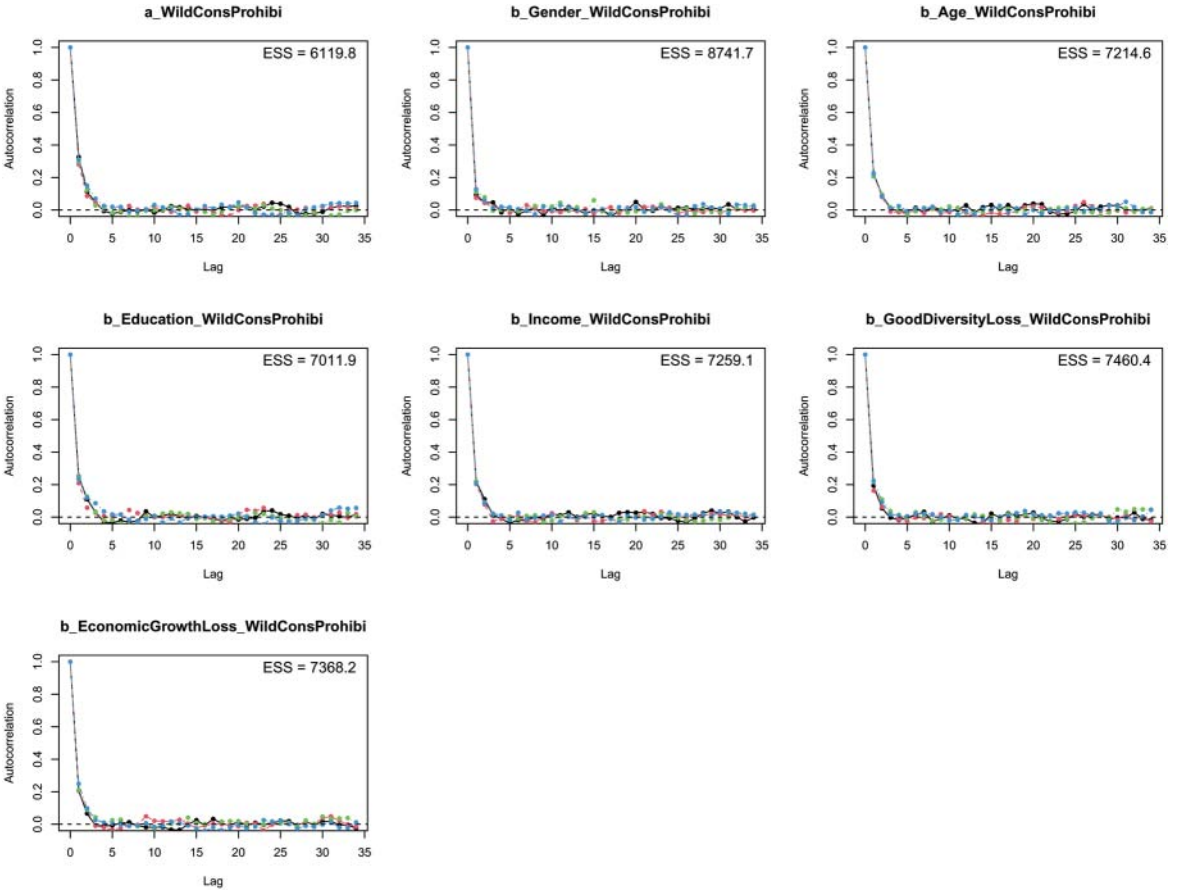

Figure A2. Autocorrelation plots.

AUTHOR BIOGRAPHY

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